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THE SCIENTIFIC
MONTHLY

MAY, 1922

THE RELATION BETWEEN RESEARCH IN HUMAN HEREDITY AND EXPERIMENTAL GENETICS

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I. INTRODUCTORY

THE workers in any primarily biological science need at frequent intervals to spend a certain amount of time in considering the research methods and aims of their science with a view to possible changes.

The more their branch of science is dependent upon or correlated with other allied sciences, the more urgent becomes such a procedure.

New discoveries of a fundamental nature in one branch of science should have a strong influence on related fields. In fact, such changes, when they exist, are bound to make their presence felt sooner or later outside their immediate field, and it is the desire to assure that it be "*sooner*" rather than "*later*" that justifies the expenditure of time and effort in continually looking about for such unutilized or unfulfilled relationships.

The sooner any such relationship is recognized and admitted, the sooner can progress of a firm and lasting nature be made in both branches of research concerned.

It is with just such a relationship between the genetical aspect of eugenics and the field of experimental genetics that the present paper hopes to deal. The existence of this relationship has long been admitted, but the full scope of its extent, possibilities, and responsibilities does not seem to be completely realized at present.

In order to bring out the facts in the case more clearly, it will first be advisable to review briefly the general lines of progress in research on human heredity in the past two decades. We may then consider this progress in its relationship to the contemporary advance in the field of experimental genetics, and in so doing bring out the need for certain changes in the methods of research in human heredity. Finally, we may outline a program of possible studies in human genetics which could be undertaken at once, be built up gradually, and eventually be utilized as the foundation of a more exact and lasting approach to our proper understanding of the inheritance of human traits.

II. The Past Progress of Research in Human Genetics

Investigations in the genetic aspect of eugenics may be said to have progressed along two main lines, or perhaps better, from two different viewpoints. On the one hand, biometrical interpretation of data has been continued by the Galton laboratory, under the direction and leadership of Karl Pearson, while, on the other hand, the search for mendelizing characters has been carried on chiefly by the American School of Eugenicists under Davenport.

The biometric school, which has avowedly used statistical methods and a non-mendelian approach to the problem, has established the *fact* of inheritance of many traits. Such publications as "The Treasury of Human Inheritance" and "Biometrika" contain the records of a great number of painstaking and meritorious investigations by this group of workers. The *type* of inheritance involved, however, remains, under these methods of analysis, obscure and unapproachable.

The mendelian school has gone farther, for, in addition to having established the *fact* of inheritance for many traits, it has been able in not a few cases to procure evidence bearing on the *type* of inheritance as well.

The exactness with which the cases of mendelian inheritance in man have been established is not, and can not be, under present methods, of the same order as that of a result based on experimentations. The question of which cases are, and which cases are not, well established is, therefore, to some degree a matter for personal opinion.

We may, however, take the opinion of a careful and conservative geneticist, such as Castle, as a fairly safe guide in estimating the number of cases of apparently mendelizing characters in man.

In his text-book on "Genetics and Eugenics," 1920, Castle lists some twenty-three characters as having been found to be mendelian, and approximately thirty-two others as either "non-mendelian" or unanalyzed. In presenting these cases there have been many publications from, or inspired by, the Eugenics Record Office of the Carnegie Institution of Washington. This institution has indeed provided funds and personnel for the great majority of the research which has procured the evidence for the type of inheritance involved in most of the cases recorded by Castle. To a consideration of the ultimate value of this work, we shall return later. In the meanwhile one may mention such researches as those of Goddard on feeblemindedness, of Davenport and Weeks on epilepsy, of Bulloch and Fildes on hemophilia, and of Estabrook on the Jukes, to obtain an idea as to the sort of research that lies at the basis of the cases cited by Castle.

Recently the work of Mohr, on brachyphalangy, and of Stanton and Seashore, on musical ability, has continued, by methods of direct observation, the lines of mendelian analysis in as careful and painstaking a manner as the means of collecting the data have made possible. Their work represents the farthest advance in methods at the present time.

Without going into the details of the work cited, we may say that upon the rediscovery of mendelism, efforts were made by the majority of eugenicists to extend that law to humans, and that, broadly speaking, these efforts have been successful.

III. The Relation of Progress in Genetics to Eugenic Problems

While these investigations in human heredity have been under way, research in experimental genetics has been far from idle. Its progress has, in fact, been enormous, and the relatively recent developments of our knowledge as to the basis of certain hereditary characters has brought to light new genetic principles of the greatest importance.

Thus, to Mendel's original laws of segregation and of independent assortment and recombination of the genes, we find added, by the work of Morgan and his associates, linkage, crossing over, limitation of linkage groups, and the intra-chromosomal questions of interference and the order of the genes.

Obviously, these new discoveries open up a wide horizon, and introduce us to a type of detailed genetic analysis not formerly imagined. They also, however, focus our attention upon the nature of our data on human inheritance, in order to observe whether these data are sufficiently accurate to be amenable to analysis by the finer tests mentioned above.

When this question is calmly and dispassionately considered, we are forced to the conclusion that data on human inheritance, collected by the present methods, are not sufficiently accurate to justify their being used to determine the degree of linkage or crossing over, or such matters as the limitation of linkage groups, interference, or the order of the genes.

Thus, while "family histories" and reports of field workers give information of greater scientific value than data less carefully obtained, they have certain fundamental and unavoidable inaccuracies. For example, evidence obtained by field workers concerning the individuals who are themselves interviewed is probably fairly accurate. So, too, is the documentary evidence submitted by an individual of responsibility and intelligence concerning her- or himself. The mass of information in family records, or that obtained by field workers concerning dead or absent individuals is, however, too uncertain to use in the finer methods of genetic analysis.

It is the fact that geneticists have clearly recognized this situation, while many eugenicists have given little sign of having done so, which has brought about the existing prejudice. Such prejudice certainly exists to a marked degree and forms one of the most unfortunate but telling bits of evidence of the need for radical changes in the method of eugenic research.

There can, moreover, be no narrowness present as a factor in the situation, for the geneticist has been living in plenty and does not wish a changed attitude on the part of the eugenicist for any selfish reason. Rather he expects of the eugenicist merely a critical attitude, involving realization of the fundamental weakness in his data and steps to correct it.

While experimental genetics was in its infancy, (1905-1910), one did not hear from geneticists so much criticism against, or sense so much distrust for eugenicists. Because, however, since that time, eugenics has made little or no progress towards a truly experimental attitude we now find a real breach between these two sciences. This is most unfortunate, for they should be closely related and entirely sympathetic.

Undoubtedly the geneticists have been a bit unreasonable in expecting the immediate adoption of experimental methods by eugenicists. On the other hand, there is much to justify their attitude of criticism. Thus we find that among more than one hundred papers given at the recent International Congress of Eugenics, not one paper on human genetics introduced us to data of sufficient accuracy to provide evidence on the degree of linkage, the order of the genes, or the size and nature of linkage groups.

Another piece of evidence as to the rôle played by the work in human heredity in the advance and conduct of experimental genetics is seen in the bibliography of a modern text-book such as Morgan's "Physical Basis of Heredity." Here, among approximately six hundred references, we find less than two per cent. are to works dealing primarily with human heredity.

Evidence of this kind must not be taken as an indication that we should expect research in human heredity to prove the best field for pioneer work in experimental genetics. To do this would be asking too much. There is, however, a serious aspect to the question when we realize that present methods in human inheritance studies will not give us the chance to utilize the definite methods of genetic analysis now possible. It is not a matter for chagrin, but involves an unfulfilled duty. If eugenics is ever to be an applied science, it must be able to predict with a fair degree of accuracy the results of individual matings. Without this, no practical system of mate selection can be suggested. Since the question of mate selection is daily becoming of more general interest, this line can not and should not be avoided. If advice as to what type of consort shall be chosen is given in individual cases under the conditions of our present incomplete knowledge of quantitative values in human heredity, we shall soon be in serious trouble. This will result if and when advice is given and followed with a markedly unsuccessful outcome. A few such cases would be sure to give the existing interest and confidence in the eugenic movement a severe and possibly permanent setback.

The non-scientific public expects great achievements and accuracy in the case of any process which is supposed to be scientific. If, however, ''science'' fails, they are quick to turn and rend it with ridicule and an exaggeration of its weakness. This means that those who have at heart the success of the eugenic movement, must, therefore, before it is too late, take a definite stand against overinterpretation of data within their particular field, or else be prepared to experience an ever increasing lack of sympathy on the part of the biological sciences and the educated public.

As before stated, it seems that we owe it to the future of human genetics to face the situation fairly and frankly. To do this, the fundamental interdependence of experimental genetics and human genetics has been made the keynote of the situation.

In working out a program for work on human genetics, we are faced with certain inherent characteristics of our material. The fact that these form definite limitations in some cases, forces our attention to them whether we desire it or not. In considering them, however, we shall, I think, find that the obvious disadvantages are not without some compensations and alleviating circumstances, which may easily be turned to our advantage.

Thus, while the slow breeding of mankind makes it impossible to expect or hope for the great numbers obtainable from laboratory material, and lengthens the space between generations to a somewhat disquieting degree, yet it offers opportunities of a peculiar nature as well.

For example, the long period of adolescence gives us a remarkable chance to develop to the fullest extent the study of the unfolding during ontogeny of the hereditary traits, and to weigh with a high degree of detail the influence of such external agents as training, education, and other similar forces, upon the individual and its descendants. We can and should know our human individual—whether ancestory or progeny—in as many stages of his ontogeny as we possibly can. This is the peculiar opportunity afforded by human material. We can not ignore it by attempting a classification of our individual based on fragmentary information—but, rather, we should utilize it to the fullest extent. What might then, at first, be considered as a handicap, may with patience and careful planning be turned into a valuable asset. No insect material can give us this chance—and when we consider that laboratory mammals afford us an excellent basis for the development of methods of research applicable to humans and for a "comparative" genetic analysis—we begin to see the real possibilities of the situation.

In a somewhat similar way it has been objected that in man we can not control the matings made; this indeed is true. But if we can not control the matings, we can, at least, record them and, by finger prints and blood tests, check on data. This is no small advantage, and makes the eventual utilization of carefully collected data certain and of great value.

We have already dwelt on the inaccuracy of information based on anything short of exact tests or measurements of the individual in question—an inaccuracy which makes change imperative. As an aid in establishing and extending the desired methods of observation and recording, will come the definite cooperation of the individuals themselves, or of those controlling them, once results of promise can be shown.

The possibility of introducing some such program as the one suggested will be scouted by many—and in some cases, indeed, by those now engaged in eugenical research. Until a point of view generally similar to the one above outlined is adopted, however, we may expect that the work in human genetics will fail to carry real conviction to experimental geneticists and to the public at large.

It is entirely probable that the attitude that eugenics is or should be primarily dependent upon genetics may be seriously questioned. Should this be the case, however, it seems that a short consideration of the apparently non-genetic aspects of eugenics will bring home to us the fact that we are, even in these subjects, actually relying on genetic information before we can hope for progress.

Thus in the eugenic aspect of the immigration problem, we are faced at once with the fact that we are dealing with *race*—a fundamentally genetic problem. Racial *differences* in fecundity and susceptibility to disease will determine just what numerical rôle any given nationality will play in forming the future population. Differences in type of mental makeup and in degrees of mental capacities from the viewpoint of intellectual achievement, moral responsibility and adaptibility to a new environment will be essential matters in determining the value of various nationalities as sources of potential citizens. The physical and psychological traits of various combinations and types of hybrids among the different European and Asiatic nations, attained under the conditions of life in the United States, will give the best possible criterion as to their permanent value as constructive elements in the formation of the future American nation.

Similarly, the question of legislation involving eugenic measures must frequently appeal to our knowledge of genetic principles as applied to man. Unless the environmental influences not transmissible to future generations can be separated from those differences that are truly genetic, we shall be at a loss to know how strict our system of segregation and confinement of criminals should be. So, too, unless we know the degree of inheritance of criminal traits in different racial combinations, we shall not know whether a similar legislative treatment of all individuals, regardless of their racial composition, is either justified or wise. So, too, in efforts to determine parentage, genetics through blood tests may be useful if properly evaluated.

Thus, in any scheme of general education along lines of eugenic measures, we are faced again and again with the fact that the limiting factor in the situation is our knowledge of the laws of genetics as applied to the particular subject in question.

In thus presenting briefly some of the factors operative in maintaining a proper relationship between genetic research in man, and experimental genetics, an effort has been made to bring out the fact that we have reached a point where a recasting of our methods of gathering data on human inheritance for this purpose is imperative.

The work in human genetics already accomplished has given results so promising that we should be able to enter a new long-time program with enthusiasm and complete confidence as to its final outcome. If we can, in this long-time program, obtain, as we go, data for *immediate* interpretation and at the same time lay the foundation on which eventually a scientific and experimental study of human heredity may rest, we shall have initiated a line of investigation worthy of the loyal support of all experimental geneticists and of the best efforts of those intimately connected with eugenic research.

IV. The Proposed Program

A. *General Considerations.*

In suggesting a program of this type, no one can be more clearly conscious than the writer, of the need for encouraging discussion and cooperation between geneticists and eugenicists before any definite scheme of work is adopted. In fact, it is probable that an "acceptance in principle" of some such outline as that here given will be sufficient action at the onset. This will give opportunity for the introduction of modifications either of methods or materials as the work progresses. Some such elasticity is necessary, for it is not humanly possible to foresee all the problems which are bound to arise.

In the main points, however, there is real hope of agreement provided the inadequacy of present methods of collecting data is frankly admitted. Obviously, the new program to be adopted involves (1) more accurate methods of collecting data as to the biological nature of both physical and psychological traits of human individuals, (2) the utilization of data so collected for three main purposes, (a) the contrasting of naturally existing different biological groups of individuals in respect to characters recordable by direct observation, (b) the building up of an ever increasing detailed knowledge, by the method of direct observation, concerning the individuals from birth to death, and (c) the continuation of this process to include the descendants of such individuals. By this means, pedigrees will eventually shape themselves which are of sufficient accuracy to be considered quite as exact from an experimental point of view as are many of those of laboratory mammals used in genetic research.

Much is heard of the unselfishness of science and its devotees, and of their willingness to sacrifice their individual capacities and efforts in the search for truth. Yet it is doubtful whether there would be even the slightest chance for the adoption of a viewpoint similar to the above unless it can be shown that the returns to be expected during the lifetime of the observer are in themselves sufficient to enlist his interest.

Fortunately, the value of the "immediate" returns is, in the case of the suggested eugenics program, so great that one is justified in considering some of them in detail, despite the recognition of the fundamental selfish element always present, which often makes a similar consideration necessary even in other cases having little or no merit.

In outlining the possible problems to be investigated, it will be advisable to keep in mind the features of particular interest to the United States. The problems of other nations will, however, be sufficiently allied to ours to make the utilization of some slight modification of the lines of work suggested here, entirely feasible.

Bearing in mind then, that the prime requisites of the new attitude is direct observation, we must first seek to ascertain where the best opportunities for such observation exist.

B. *Opportunities and Problems.*

The chance to study human material from the various viewpoints shortly to be considered is offered at many times during the lifetime of the individual. At many of these points the information desired could be obtained with a minimum of effort and with great accuracy.

Thus, maternity hospitals, primary schools, secondary schools, colleges, city and state institutions, general hospitals (of all grades), military and naval units, factories and large commercial concerns, offices of dentists and physicians, social and church organizations, employment bureaus, boy and girl scouts, census officials, immigration stations, Y. M. C. A.'s and Y. W. C. A.'s and similar organizations are some of the points at which it would be possible to obtain data of biological value by physical or mental examinations conducted by properly trained observers.

Obviously, the earlier in the life of the individual we begin to gather the data, the more will be the genetic and the less the external contributions to its character; the earlier, also, shall we be able to recognize the initial stages in the appearance of both beneficial and harmful hereditary traits. In the former case we should be able to assure proper opportunity, physical and mental, for the exceptionally endowed individual, and, in the latter, apply at the earliest possible moment the restrictive, corrective or curative measures necessary for such deficients as might be found. The economic saving would be enormous, but even so it would be only a tiny fraction of the permanent biological benefit to the race.

Clearly, maternity hospitals provide us with the chance to observe directly the individuals at birth. Their records are, or could be made, inclusive of information concerning many physical and even mental attributes of the child. Studies on the sex-ratio, body length, weight, head form, early growth rate, incidence of abnormalities or disease are only a few of the questions easily capable of being investigated by direct observation in such institutions.

Certain of these points have already been successfully investigated in laboratory mammals or in man. As a single example of this, the variations in the sex-ratio (number of male progeny to each one hundred female progeny) may be briefly considered.

Variations in the sex-ratio are of importance economically as well as biologically. It is therefore important to investigate the various factors which underlie their modification.

Hybridization has been recognized as one such factor. R. and M. Pearl (1908) and the writer (1919) showed that in man the progeny of matings between parents of different nationalities had a higher proportion of males than those between parents of the same nationality. The same fact has been found to hold true for races of birds (Ducks, Phillips; Pigeons, Whitman, and Riddle; Pheasants, Geoffrey-Smith and Haig-Thomas; Poultry, Davenport, Pearl; and in laboratory mammals, Rats, King; Mice, Little.

In a somewhat similar way, King (1918) showed that more males proportionately occurred in the first litter among rats than among subsequent litters from the same parents, and the writer found the same to be true in humans (parents from white races and of the same nationality), when the first births are contrasted as a group with the subsequent births. This fact, for example, has a possible bearing on the popular belief that in time of war an excess of males above the "normal" ratio is produced. There might be an interesting element of truth in the popular belief, because in war time the proportion of first births in the population is greatly increased. If, now, these produce an excess of males, it would follow that this fact would be noticed and remarked on, since, at that time especially, men are at a premium.

The occurrence of sex-linked lethal factors killing approximately fifty per cent. of the male progeny in certain matings has been frequently observed in insects (Morgan and his co-workers). Evidence for their existence in mammals, (mice, Little, 1920) and in man (Little and Gibbons, 1921) has been offered. The evidence in man is statistical and can not be made more definite until our methods of collecting data have become more accurate.

The sex-ratio of stillbirths in man is a matter of the liveliest interest. On the one hand, it bears on this same question of lethal factors, and on the other, it provides important evidence on the sex-ratio at conception—and thus on the possible control of sex in mammals through the selection of one or the other type (male forming or female forming) of sperm.

So also, the sex-ratio of illegitimate births is worthy of investigation. There has been a certain amount of evidence obtained (Heape, 1908) that there is an excess of females among the progeny resulting from illegitimate births. It would be interesting in this connection to see whether the use of contraceptive methods, or possibly an unusual occurrence of endocrine abnormalities (due to the unusually high number of mental defectives among the mothers of illegitimate children) have altered the secretions of the female reproductive tract sufficiently to mean that a selection of female-forming sperm is being made, and the male-forming sperm more frequently eliminated during their passage through the female generative tract.

In the primary and secondary schools of great cities we have remarkable opportunities for work of some of the types which we have outlined. Representatives of many different nationalities are brought together in essentially similar environment and are under almost daily observation for long periods. The chance is clearly given to study differences in mental capacity of individuals, nationalities, and races. Particular talents may be studied and many of the investigations now being made with exceptional children could be extended and supported by approach from a new angle.

The preliminary experiments of Vicari (1921) on mice have shown that F_1 hybrids produced by crossing Japanese waltzing and albino non-waltzing mice (the two parent stocks being thus from different laboratory races) made a better record in learning a simple psychological problem than did either parent race. This suggests strongly that the well known phenomenon of hybrid vigor, or heterosis, applies in the case of at least some mental characteristics as well as in physical traits.

It would be of the greatest value to compare the school records and psychological tests of children whose parents are of the same nationality with those of children whose parents are from different nationalities. Later the records of back-crosses and of F_2 hybrids could be similarly studied.

So, too, the study as to whether there was correlation between general or specific mental capacity and grade of skin color in mulattos would be extremely interesting.

Growth curves and resistance to children's diseases are other matters on which children of "hybrid" and "pure" matings could be compared. In this case, if the analogy with the laboratory mammal holds, we should expect the first generation hybrids to be clearly superior.

Other viewpoints and matters for investigation as applied to the school material would be quite as important. Thus, it has been long debated with considerable warmth of feeling as to whether first-born children were inferior mentally and physically as a group, or last-born children superior as a group, to other children as a whole. The material for settling, or at least throwing light on, this point seems to be in a condition to gather in the schools.

The effect of age of parents at the time of birth of the child, or of transference of an individual from one environment to another, of birth and rearing in the city as compared with the country, are all of them interesting and contrasted points of view that may be investigated profitably and economically.

It is also, at least theoretically, possible that by the extensive use of mental tests, methods may be devised for recognizing the carriers of recessive feeble-mindedness. If this were actually accomplished, the value to the community would be enormous.

C. *Training of Observers.*

We must not send out as observers individuals who look for anything except accurate, concrete, and unbiased data. There must be no reliance on "hearsay" or "reported" evidence of any type. The judgments as to any individual's traits or abilities, physical or mental, must be recorded as standardized measurements from direct observation. In this way, any mistakes of methods or technique will become evident at the earliest possible moment, and modifications can thereupon ensue. If the "field worker report" type of information be relied on, we shall have inaccuracies continually introduced by the varying personal equations of both the observer and the observed.

The acceptance of this last general point means that a large body of observers capable of and interested in taking accurate observations must eventually be trained and organized. The need of some such body of trained observers should not, however, prove any source of worry to us. The idea of training eugenic workers for the specific purpose of research is already in practice.

At the present time, field workers so trained are sent out to collect data from a critical point of view without, in many cases, ever having performed an experiment in animal genetics. This seems to be one of the points on which genetics and eugenics clash sharply. There would perhaps be real hope for reconciling the two if such field workers had been given a laboratory course in genetics, or if they merely went out to measure and record by standardized methods certain mental or physical traits of individuals by direct observational methods. In this last case, training in accuracy, and some knowledge of each field worker's "individual error" would be indispensable.

But the training of specialized field workers, or "field observers" as they might perhaps be called, is expensive and is only one of the ways to go about gathering data based on measurements. There are in addition two great groups of individuals, either or both of which might easily be specially trained, and who could, in the course of their professional duties, obtain data of the utmost scientific value. These are medical men and the teachers of primary and secondary schools.

A properly planned and executed lecture course with demonstrations would give the average medical student some ideas on the gathering and recording of biological data. This would suffice for arousing his interest and at least introduce him to the genetic point of view. Individual researchers in eugenics or organizations conducting eugenic research could then arrange with medical men for the joint interpretation of the data which the medical man had gathered.

The same principle could be followed in the case of school teachers in whose training a course on the biology of their material, and on means of recording data could most profitably be inserted.

The suggestions as to the training of medical men and teachers, as well as to the modification of the functions of the eugenic field worker, are all of them based on essentially the same principle. This involves the clear separation of the function of *collecting and recording of data from its final interpretation,* unless all the collectors and observers are, in the highest degree, trained in scientific methods and thought in either genetics, general biology, or both. They should confine themselves to the mechanical and, in so far as possible, impersonal work of gathering data in the form of permanent, records, obtained from standard tests under direct observation.

With data of this type we should find the experimental geneticist becoming more frequently interested in a problem of human genetics than he ever can be under the existing methods.

In colleges as well as in other educational institutions, the employment of observers to collect and record data will result in educating the general population of the institution in the problem under consideration. The whole scheme will undoubtedly work out on the basis of compound interest and result in a steady increase in the numbers and efficiency of workers.

The value of collecting data in large business concerns or factories is also clear. Here one will be able to gather information as to efficiency under certain performance tests, as well as on the general mental attributes of accuracy, consistency, and industry. Psychological tests of the type of those in use in the army are already in a state of development sufficiently advanced to be of great value.

D. *Conclusion.*

The program as outlined is admittedly incomplete and in tentative form. Generally speaking, it utilizes natural gathering places of people at all ages, and by a continuation (with certain modifications) the training of eugenic field workers, together with the training of school teachers and medical men, it plans to interest an ever increasing group of observers who will gather by methods of direct observation, data on human genetics.

It proposes to decrease to a minimum, or to abandon, except for the preliminary work, methods of pedigree study as at present practiced, and by the processes outlined above to replace it gradually by pedigrees more nearly comparable in their degree of accuracy with those obtained by experimental geneticists working with mammal material.

It proposes to collect data on such subjects as birth, length and weight, head form, sex-ratio, rate of growth, susceptibility to disease, incidence of abnormalities (morphological and physiological), mental capacity, specific and general, age at maturity, as well as the variations commonly recorded such as hair color, shape, eye color, skin color, et cetera.

Furthermore, as indicated above, any and all of these points may be analyzed on the basis of contrasting the progeny of relatively pure (inbred) and hybrid (outbred) matings, of first births as compared with subsequent births, of young parents as compared with old, of negro with white and other racial types, of country bred parents with city bred, of college graduates with non-college graduates, of parents who were first children compared with those who were not, of brunettes versus blondes within any particular nationality, of parents suffering with various diseases as opposed to those not so afflicted, of births out of wedlock compared with legitimate births, of parents from tropical climates as compared with those from temperate or arctic, and eventually of children born to the same parents in one climate compared with those born from the same parents in a new environment.

The above plan has its justification in the belief that under the present methods the breach between eugenicists and geneticists will become wider and wider, and without it eugenics will not be able to utilize the existing genetic methods of analysis and so maintain its place among the truly experimental sciences. Because the permanent welfare of the eugenic movement is at present prejudiced, a radical and immediate shift in viewpoint on the part of those directing eugenic research and thought is urged.

By looking ahead to the time when the pedigrees built on the new plan are beginning to take definite form, we can rest assured that there will be ample reward in the shape of information sufficiently accurate to warrant a detailed program of "mate selection" work at just about the time that the public as a whole is ready for it, and in an approach to the problems of human heredity in a way not now possible.

In the meantime, we shall have accomplished a great amount of research of direct biological and economic value to our country, and shall have laid a firm and respected foundation for research in human genetics throughout the world.